PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2002-289604**

(43)Date of publication of application : **04.10.2002**

(51)Int.Cl. **H01L 21/314**
H01L 21/312
H01L 21/316
H01L 21/768

(21)Application number : **2001-090876**

(22)Date of filing : **27.03.2001**

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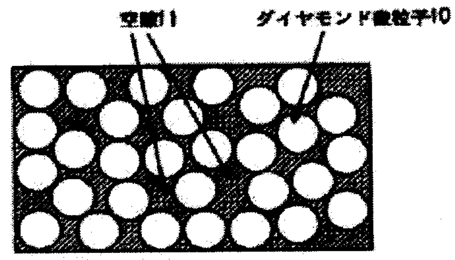
(54) CIRCUIT BOARD AND ITS MANUFACTURING METHOD

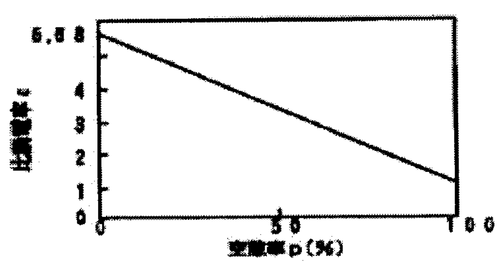
(57)Abstract:

PROBLEM TO BE SOLVED: To produce a low permittivity film for eliminating wiring signal delay causing a problem in a circuit board having high integration fine pattern wiring, e.g. a super LSI, with high efficiency.

SOLUTION: The substrate of a semiconductor integrated circuit is spin coated with diamond colloid solution produced by dispersing fine diamond particles of nanometer size into water or an organic solution and then dried to form an insulation layer of low permittivity porous structure diamond film where the fine diamond particles are dispersed uniformly through air gaps of nanometer size (nano pores). Then the substrate is exposed to a vapor of a crosslinking molecule material such as hexachloro-di-siloxane to enhance the strength of the film by chemically bonding the fine diamond particles.



(a) ダイヤモンド膜のポーラス構造



(b) ポーラス構造ダイヤモンド膜の空隙率と比誘電率の関係

CLAIMS

[Claim(s)]
[Claim 1]A circuit board having the diamond membrane in which diamond microparticles are combined with a minute void distributed uniformly.
[Claim 2]The circuit board according to claim 1, wherein the structure of cross linkage by bridge construction molecule material which has a hydroxyl group on the surface of diamond microparticles and two combinable functional groups or more in a bond part of diamond microparticles exists.
[Claim 3]The circuit board according to claim 2, wherein bridge construction molecule material is hexachloro disiloxane.
[Claim 4]Claim 1, wherein particle diameter of diamond microparticles is 100 nm or less thru/or the circuit board according to claim 3.
[Claim 5]Claim 1, wherein voidage of diamond membrane is above 57% thru/or the circuit board according to claim 4.
[Claim 6]Specific inductive capacity of diamond membrane is 3.0. Claim 1 being the following thru/or the circuit board according to claim 5.
[Claim 7]A manufacturing method of a circuit board, wherein diamond microparticles have a process of generating a solution uniformly distributed in a solvent, a process of applying this solution to a substrate, and the process of diffusing a solvent in a this applied solution and forming diamond membrane, at least.
[Claim 8]A manufacturing method of the circuit board according to claim 7 including a membrane structure strengthening process after a process of diffusing a solvent and forming diamond membrane.
[Claim 9]A manufacturing method of the circuit board according to claim 8, wherein a membrane structure strengthening process is a process of irradiating diamond membrane with ultraviolet rays and promoting dehydration of the hydroxyl groups on the surface of diamond microparticles.

[Claim 10]A manufacturing method of the circuit board according to claim 8, wherein a membrane structure strengthening process is a process to which between diamond microparticles of diamond membrane is connected by a bridge construction molecule.
[Claim 11]A manufacturing method of the circuit board according to claim 10, wherein a bridge construction molecule is a molecule with a hydroxyl group and two combinable functional groups or more.
[Claim 12]A manufacturing method of the circuit board according to claim 11, wherein a bridge construction molecule is hexachloro disiloxane.
[Claim 13]A manufacturing method of the circuit board according to claim 7 characterized by using fluorohydrocarbon system solvents, such as saturated hydrocarbon system solvents, such as alcohols solvents, such as pure water or ethanol, or hexane, or perfluorohexane, for a solvent in a process of generating a solution.
[Claim 14]A manufacturing method of the circuit board according to claim 13 characterized by adding a viscosity controlling agent of an organic high polymer to a solvent in a process of generating a solution.

[Claim 15]A manufacturing method of the circuit board according to claim 7 characterized by impressing an ultrasonic wave and distributing diamond microparticles in the state of a simple substance or particle floc in a process of generating a solution after suspending diamond microparticles by predetermined concentration in a solvent.
[Claim 16]A manufacturing method of the circuit board according to claim 15 adjusting power and applying time of an ultrasonic wave, and controlling size or a particle number of floc of diamond microparticles by a process of generating a solution when distributing diamond microparticles by impression of an ultrasonic wave.
[Claim 17]A manufacturing method of the circuit board according to claim 15 characterized by particle diameter of diamond microparticles being 100 nm or less in a process of generating a solution.
[Claim 18]The number of particles which constitute diamond-microparticles floc from a process of generating a solution is 10000 from about ten. A manufacturing method of the circuit board according to claim 15 in the range of a grade.
[Claim 19]A manufacturing method of the circuit board according to claim 7 characterized by using a spin coat method in a process of applying a solution to a substrate.
[Claim 20]A manufacturing method of the circuit board according to claim 7 characterized by carrying out stoving at temperature of the range of 200-500 ** in a process of diffusing a solvent in an applied solution.
[Claim 21]A manufacturing method of the circuit board according to claim 7 characterized by repeating an application process and a stripping process two or more times when required in order to obtain desired thickness.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to a circuit board which attained lower dielectric constant-ization by the film of the porous (porosity) structure which combined especially diamond microparticles about a circuit board for Integrated Circuit Sub-Division which can do high-speed operation, and a manufacturing method for the same with the degree of high integration, and a manufacturing method for the same.
[0002]
[Description of the Prior Art]In the semiconductor very large scale integration device, the delay of the signal which passes the wiring built in a circuit board poses a big problem with the miniaturization and high integration of wiring. Especially in high-speed devices, such as logic, in order that RC delay by resistance and distributed capacity of wiring may have been the biggest problem and may make distributed capacity small especially, to use the material of a lower dielectric constant is needed for the insulating material between wiring.
[0003]Conventionally, the silica membrane (SiO_2) which added fluoride and an organic matter is used as a low dielectric constant film as an insulating material between the multilevel interconnection in Integrated Circuit Sub-Division. What heat-treated an organic silica material which has fizz, the porous silica membrane which laminated and formed the silica particle, the use of the organic system polymer material which does not contain silica, etc. are considered by making an insulator layer into the method of lower-density-izing for the further lower-dielectric-constant-izing.
[0004]However, the material of a silica system comprises two or more sorts of atoms, and since the oxygen atom with high electronegativity is moreover included as the main ingredients, in order that the big orientation polarization which is one of the factors which make a dielectric constant high may remain, there is a limit in lower dielectric constant-ization. Since the pyrolysis temperature of an organic high polymer is intrinsically low even if it is possible in the case of an organic system polymer material to make orientation polarization small and to lower-dielectric-constant-ize it, there is a problem that it is difficult to raise a heat-resistant temperature required for a circuit board.
[0005]In the case of the porous silica membrane by silica particle lamination, Since it is difficult for particle shape to have diversity since the particles to be used are amorphous, and to make distribution of grain size small, Nano pore (fine pores with the path about nano meter) reaches far and wide mutually, it becomes easy to continue, fine pores are connected, and there is a problem in the point of reducing a mechanical strength required for a circuit board.
[0006]On the other hand, these days comes, and since the technology of manufacturing the diamond microparticles in which particle shape distribution has small and almost uniform particle diameter by low cost was developed, applying the film of a diamond to a circuit board has come to be examined concretely. Since the diamond has the thermal conductivity (2,000 W/mK) and mechanical strength which excelled other materials in each stage, it is a material effective in the circuit board which has a high degree of location, and much calorific value. the example of one of the technology which used such diamond membrane for the circuit board is indicated to patent

documents [No. publication-number 6- 97671 gazette (applicant: , Inc. Toshiba)]. In this technology, diamond membrane with a thickness of 5 micrometers which constitutes an insulating layer is created by the producing-film methods, such as a sputtering method, a CVD method, the ion plating method, and the ionized cluster beam method, and the thermal conductivity for diffusing the heat which a circuit element generates to a base material is improved. In order to prevent the signal propagation delay of a wiring section, the circumference of wiring is covered with the low dielectric constant film of borosilicate glass. However, since harmful gas and combustible gas were used for the CVD method for the diamond membrane formation used with this technology, there was a problem in the field of safety.
[0007]
[Problem to be solved by the invention]In a circuit board with highly integrated and fine wiring, such as very large scale integration, although the conventional trial in which diamond membrane is used for a circuit board is made paying attention to the high thermal conductivity and mechanical strength which diamond membrane has, Since there is a problem in the safety at the time of manufacture, such as using harmful gas in the CVD method used for film production of diamond membrane, and, as for the specific inductive capacity of a diamond, the distributed capacity of wiring becomes large by 5.68 and signal propagation delay becomes a problem, Wrap necessity had producėd the circumference of wiring by the film of another low dielectric constant material. As a result, complication of the manufacturing process of an integrated circuit was not able to be caused and the rate of productivity was not able to be made not much high.
[0008]There is problem of this invention in manufacturing highly efficiently the low dielectric constant film for canceling the wiring signal delay which poses a problem at a comparatively easy process, and making higher the mechanical strength of a low dielectric constant film.
[0009]
[Means for solving problem]This invention by making substrates, such as Integrated Circuit Sub-Division, apply and dry the colloidal solution containing the diamond particle of nano metric size, Diamond microparticles form the insulating layer of the porous structure diamond membrane of the lower dielectric constant currently uniformly distributed with the void of nano metric size. By the crosslinking treatment between diamond microparticles, the number of chemical bonds between particles is made to increase, and the intensity of diamond membrane is raised.
[0010](a) of drawing 1 shows the porous structure of the diamond membrane by this invention. A film is formed in the state where it was combined mutually, the minute void 11 is distributed almost uniformly between diamond microparticles, and the diamond microparticles 10 are making porous structure. Specific inductive capacity can be easily reduced by adjusting the porous degree of diamond membrane, i.e., voidage.
[0011](b) of drawing 1 shows the relation of the voidage p and the specific inductive capacity epsilon of porous structure diamond membrane. If the value of the specific inductive capacity epsilon of diamond membrane changes the voidage p from 0% to 100 %, it will change linearly between the specific inductive capacity 5.68 of a diamond simple substance (bulk), and the specific inductive capacity 1 of air.
[0012]The diamond membrane of porous structure makes the solution which distributed diamond microparticles in the solvent by suitable concentration, applies the solution to a substrates face (field of the foundation layer in a substrate), and can form it by making it dry. The processing which forms bridge construction between diamond microparticles by carrying out UV irradiation of the diamond membrane after desiccation, and promoting the dehydration of the hydroxyl groups on the surface of diamond microparticles, The mechanical strength of diamond membrane can be raised by exposing diamond membrane to a bridge construction molecule material steam by performing both both [either or] which perform chemical multipoint structure-of-cross-linkage-ization by a bridge construction molecule between diamond microparticles.
[0013]Drawing 2 shows the chemical multipoint structure of cross linkage by the bridge construction molecule of this invention.
[0014]Drawing 1 and drawing 2 explain the strengthening mechanism of the membrane structure by a crosslinking process.
[0015]In drawing 2 (a), many hydroxyl groups (-OH) exist in the surface of the diamond

microparticles 10. A bridge construction molecule with this hydroxyl group and two functional groups or more in which a reaction is possible is made to trespass upon the void 11 of diamond microparticles. A bridge construction molecule makes the chemical bond 12 between adjoining diamond microparticles, as shown in drawing 2 (b). Since a chemical bond can be carried out in three dimensions in respect of a large number by which this crosslinking process is equivalent to the length of a bridge construction molecule between diamond microparticles to the bridge construction (-O -) by the dehydration of hydroxyl groups being about one-point junction, a joint can increase and a mechanical strength can be made higher.

[0016]The diamond membrane and the manufacturing method of the porous structure by this invention are constituted according to each following item.

(1) Composition of the circuit board having the diamond membrane in which diamond microparticles are combined with the minute void distributed uniformly.

(2) Composition of a circuit board given in the preceding clause 1, wherein the structure of cross linkage by the bridge construction molecule material which has a hydroxyl group on the surface of diamond microparticles and two combinable functional groups or more in the bond part of diamond microparticles exists.

(3) Composition of a circuit board given in the preceding clause 2, wherein bridge construction molecule material is hexachloro disiloxane.

(4) Composition of a circuit board given in the preceding clauses 1-3, wherein the particle diameter of diamond microparticles is 100 nm or less.

(5) Composition of a circuit board given in the preceding clauses 1-4, wherein the voidage of diamond membrane is above 57%.

(6) The specific inductive capacity of diamond membrane is 3.0. Composition of a circuit board given in the preceding clauses 1-5 being the followings.

(7) Composition of the manufacturing method of a circuit board, wherein diamond microparticles have the process of generating the solution uniformly distributed in the solvent, the process of applying this solution to a substrate, and the process of diffusing the solvent in the this applied solution and forming diamond membrane, at least.

(8) Composition of the manufacturing method of a circuit board given in the preceding clause 7 including a membrane structure strengthening process after the process of diffusing a solvent and forming diamond membrane.

(9) Composition of the manufacturing method of a circuit board given in the preceding clause 8, wherein a membrane structure strengthening process is what irradiates diamond membrane with ultraviolet rays and promotes the dehydration of the hydroxyl groups on the surface of diamond microparticles.

(10) Composition of the manufacturing method of a circuit board given in the preceding clause 7, wherein a membrane structure strengthening process is a process to which between the diamond microparticles of diamond membrane is connected by a bridge construction molecule.

(11) Composition of the manufacturing method of a circuit board given in the preceding clause 10, wherein a bridge construction molecule is a molecule with a hydroxyl group and two combinable functional groups or more.

(12) Composition of the manufacturing method of a circuit board given in the preceding clause 11, wherein a bridge construction molecule is hexachloro disiloxane.

(13) Composition of the manufacturing method of a circuit board given in the preceding clause 7 characterized by using fluorohydrocarbon system solvents, such as saturated hydrocarbon system solvents, such as alcohols solvents, such as pure water or ethanol, or hexane, or perfluorohexane, for a solvent in the process of generating a solution.

(14) Composition of the manufacturing method of a circuit board given in the preceding clause 13 characterized by adding the viscosity controlling agent of an organic high polymer to a solvent in the process of generating a solution.

(15) Composition of the manufacturing method of a circuit board given in the preceding clause 7 characterized by impressing an ultrasonic wave and distributing diamond microparticles in the state of a simple substance or particle floc in the process of generating a solution after suspending diamond microparticles by predetermined concentration in a solvent.

(16) Composition of the manufacturing method of a circuit board given in the preceding clause 15 adjusting the power and applying time of an ultrasonic wave, and controlling the size or the particle number of floc of diamond microparticles by the process of generating a solution when distributing diamond microparticles by impression of an ultrasonic wave.
(17) Composition of the manufacturing method of a circuit board given in the preceding clause 14 characterized by the particle diameter of diamond microparticles being 100 nm or less in the process of generating a solution.
(18) The number of the particles which constitute diamond-microparticles floc from a process of generating a solution is 10000 from about ten. Composition of the manufacturing method of a circuit board given in the preceding clause 16 in the range of a grade.
(19) Composition of the manufacturing method of a circuit board given in the preceding clause 7 characterized by using a spin coat method in the process of applying a solution to a substrate.
(20) Composition of the manufacturing method of a circuit board given in the preceding clause 7 characterized by carrying out stoving at the temperature of the range of 200 - 500 ** in the process of diffusing the solvent in the applied solution.
(21) Composition of the manufacturing method of a circuit board given in the preceding clause 7 characterized by repeating an application process and a stripping process two or more times when required in order to obtain desired thickness.
[0017]
[Function]Orientation polarization and ionic polarization do not exist among the charge polarization which determines the dielectric constant of material, and a diamond has the feature that electronic polarization is also small. Decomposition temperature is also high. However, since specific inductive capacity is as high as 5.68 as compared with the low dielectric constant material of others [the simple substance of a diamond], it is not suitable for the low dielectric constant material of a circuit board as it is. Then, the dielectric constant was reduced by forming the diamond membrane of porous structure with a minute crevice.
[0018]When distribution of particle diameter produces small diamond microparticles by the applying method, the diamond membrane which particles joined together and was formed can make high a mechanical strength and thermal conductivity required since a circuit board is constituted.
[0019]If voidage of diamond microparticles is considered as the above 57%, it will be specific inductive capacity 3.0. The following is obtained and this serves as a value which is equal compared with other specific inductive capacity of a low dielectric material.
[0020]By the particle diameter of diamond microparticles being 20 nm or less, the size of a void can be about 20 nm or less, and it is possible to be precisely filled up with the outside of an inside of a slot by diamond microparticles also in the very large scale integration which has the detailed groove structure which is a 100 nm grade.
[0021]The layer of arbitrary thickness is obtained by repeating an application process and a stripping process two or more times.
[0022]Combination of particles will become still firmer if UV irradiation is carried out after a stripping process.
[0023]Combination of particles will become still firmer if the structure of cross linkage is made from bridge construction molecule material between diamond microparticles after a stripping process.
[0024]
[Mode for carrying out the invention]The suitable embodiment of this invention is described below. The definition used in this explanation is as follows. "Diamond microparticles": By the isotope of carbon with a diamond crystal structure, particle diameter says the particle of the nano size which is 1 nm to 1,000 nm. The "diamond like carbon" described in the above mentioned patent documents is not contained. In the case of the particle diameter over 1,000 nm, the bond strength between particles required for the composition of a circuit board is not obtained by film production by the applying method, either, and since manufacture is difficult about a particle of 1 nm or less, it is excepted. The good crystalline thing is compounded by the high pressure process or the gaseous phase method, and a commercial item can obtain diamond

microparticles easily. "The void distributed uniformly": Voids are space other than diamond microparticles, and say the space part after a solvent evaporates. Also when some solutions remain, it includes in a space part. It says uniformly that distribution is not the thing which has an intentional void and which it was, and was carried out and was locally generated with dispersion on a manufacturing process. The state where fine pores are distributed over the fixed range by the same density is said.
"Layer": Say the portion constituted with fixed thickness by the whole or the part on a substrate. By processing after film production, also when divided by metallic wiring, it contains. It contains, what [not only] is not necessarily in a base material and parallel but when the layer is being made in the direction of other.
[Working example 1] One working example of the manufacturing process which forms the porous structure diamond membrane by this invention on a substrate is shown in drawing 3. As shown in a figure, this manufacturing process comprises five processes of generation of ** colloidal solution, ** spin coat, ** desiccation, membrane structure strengthening by ** UV irradiation, and membrane structure strengthening by ** bridge construction molecule.
** In the generation process of the generation process colloidal solution of a colloidal solution. Ultrasonic dispersion of the diamond microparticles is suspended and carried out to solvents, such as fluorohydrocarbon solvents, such as saturated hydrocarbon solvents, such as alcohols solvents, such as pure water or ethanol, or hexane, or perfluorohexane, and diamond microparticles are distributed in a solution. In order to adjust the viscosity of a colloidal solution, a polyethylene glycol (PEG) is added. In viscosity control, oxygen is contained in a molecule besides PEG, and the organic high polymer about 300 ** which can comparatively be disassembled at low temperature is usable. Viscosity of a colloidal solution can be made high by PEG addition, and formation of a thicker film is attained in the following spin coat process.
[0025]When performing ultrasonic dispersion, by changing the power and time of an ultrasonic wave to impress, the aggregate size of diamond microparticles can be controlled and it is possible to control the porous degree (voidage) of diamond membrane as the result. When time is long enough, diamond microparticles are roughly [the power of an ultrasonic wave] separated separately thoroughly, but it will become close to close packed structure in that case, and the porous degree of diamond membrane will be 50% or less. In order to make porous degree into not less than 50% and to make a dielectric constant low enough, it is desirable to form floc in the size which consists of ten or more diamond microparticles, to make those flocs connect by network and to form a film. Since the floc in which aggregate size exceeds 200 nm will increase if the particle number of floc exceeds 10000, the insulator layer formation to the minute pattern of very large scale integration becomes difficult.
** Apply a spin coat process colloidal solution to a substrates face with a spin coat method. Therefore, a substrate is rotated, and the solution which trickled the solution into the substrates face and trickled it diffuses according to a centrifugal force, and is thinly applied to a substrates face uniformly. Although the applying methods include the curtain coat method besides a spin coat method etc., it is a point which adjustment of thickness tends to carry out, and a spin coat method is advantageous.
** Carry out stoving of the colloidal solution film thinly applied to the drying stage substrates face, carry out stripping removal of a solvent and the additive agent, and form the diamond membrane of porous structure. Cooking temperature is performed in the range of 200 - 500 ** which an organic high polymer decomposes. In the case of this stoving, some diamond microparticles which touch in a film carry out dehydration condensation of the surface hydroxyl groups, and they form the structure of cross linkage.
** By irradiating further with an ultraviolet (UV) line the diamond membrane of the porous structure by UV irradiation by which membrane structure strengthening process formation was carried out, and making it promote the dehydration of the hydroxyl groups on the surface of diamond microparticles, The structure of cross linkage between diamond microparticles is made to increase, and the intensity of porous structure diamond membrane is raised.
[0026]It is possible by repeating the process of ** and **, or the process from ** to **, and laminating a film to form the film of arbitrary thickness. It is also possible to change

membraneous qualities, such as a membranous degree of cross linking, to a thickness direction. **. Pass the membrane structure strengthening process by UV irradiation after the membrane structure strengthening process drying stage by a bridge construction molecule. Diamond membrane is exposed to the steamy atmosphere of bridge construction molecule material with the hydroxyl group on the surface of diamond microparticles like hexachloro disiloxane, and two combinable functional groups or more, and the chemical geometry of a multipoint is formed between diamond microparticles.

[0027]As a hydroxyl group and a functional group in which a reaction is possible, a chlorosilyl group (-SiCl) and alkoxy silyl groups (-SiOA) are mentioned. As a molecule which has two chlorosilyl groups in intramolecular, there is hexachloro disiloxane ($SiCl_3OSiCl_3$:HCDS) shown in drawing 4. HCDS carries out the chemical bond of between hydroxyl groups by a dehydrochlorination reaction, as shown in drawing 4. Since HCDS is evaporated at ordinary temperature and enters easily in the void of porous diamond membrane, it is excellent as a bridge construction molecule.

[0028]In the chemical bond of drawing 4, since the junction angle of Si atom is the same, the arm of the upper and lower sides of Si atom is combinable with other hydroxyl groups of diamond microparticles (not shown). Methoxysilane ($-SiOCH_3$) and an ethoxysilane ($-SiOC_2H_5$) are mentioned as an example of alkoxy silyl groups (-SiOA). A chemical bond can be made to constitute similarly using the molecule which has two or more of these bases in intramolecular.

[Working example 2] One working example which applied the diamond membrane of the porous structure of this invention to the bilayer circuit board for integrated circuits is shown in drawing 5. The figure shows the partial section of the bilayer circuit board.

As for a barrier layer and 3, one in a figure is [metallic wiring and 5] the diamond enveloping layers of porous structure the diamond layer of porous structure, and 4 a base material and 2.

[0029] [0029]. The NDO layer 3 of a die is in Integrated Circuit Sub-Division.

It is a velum and lower dielectric constant-ization by having porous structure.

The monodisperse thing of 20 nm or less of the size of the diamond microparticles used for this layer is desirable. It is the specific inductive capacity of the diamond layer 3 by porous structure 3.0 The above is [57% of voidage] required in order to lower to below. In order to prevent the moisture absorption with porous structure of the diamond layer 3, and diffusion of the metal of the metallic wiring 4 from arising, the barrier layer 2 is formed in the interface with the diamond layer 3, the base material 1, and the metallic wiring 4. A film with precise silicon oxide film, silicon nitride film, carbonization silicone film, organic system poly membrane, etc. is used for the barrier layer 2.

[0030]The diamond enveloping layer 5 is the last protective film in Integrated Circuit Sub-Division which uses porous structure diamond membrane. In the case of this enveloping layer 5, it makes it possible to use a thing of 100 nm or less as size of diamond microparticles, to improve the heat conduction characteristics by a diamond, and to draw generation of heat of an integrated circuit outside efficiently.

[Working example 3] One working example of the manufacturing process of the porous structure diamond membrane by this invention is shown below.

(1) Diamond microparticles with a mean particle diameter of 4.4 nm were distributed by concentration 5% in pure water. Furthermore, the polyethylene glycol of the molecular weight 600 was added 1%, and the equalized solution was prepared.

(2) The solution was dropped and applied on the base material which is rotating at 1,000 rpm with the spin coat method.

(3) In the atmosphere, it heats to 300 ** for 1 hour, it was dried, and the film was produced.

[0031]Drawing 6 shows the scanning electron microscope photograph of the section of the manufactured porous structure diamond membrane. Signs that nano pore about 10 nm in diameter is distributing uniformly are known. The specific inductive capacity which measured the refractive index and for which it asked by square [the] was 2.72, and voidage was 63%.

[Working example 4] Drawing 7 shows one working example of the process at the time of applying

the porous structure diamond membrane of this invention to the stopper of a metallic wiring CMP (chemical polishing) process. The figure shows details process [of metallic wiring formation] **, **, and ** by the partial section of the circuit board.
As for a layer insulation layer and 7, 1 is [a metal layer and 9] metallic wiring the diamond layer of porous structure, and 8 a base material and 6.

** Form the diamond layer 7 of porous structure in the upper part of the groove pattern formation process layer insulation layer 6, and form the hole and groove pattern for metallic wiring embedding by lithography and dry etching processing. The layer insulation layers 6 are low dielectric constant materials, such as silicon oxide, fluoride content silicon oxide, and an organic system insulation film.
** Deposit the metal layer 8 on the substrate with a pattern formed by wiring process process **. Materials, such as copper and the copper alloy material which were formed with a sputtering method, a CVD method, and plating, aluminum and an aluminum alloy, or tungsten, were used for the metal layer 8.
** In order to remove the metal layer of a polishing process hole and the groove pattern upper part, carry out grinding treatment. Since the diamond layer 7 of porous structure was a stable material also mechanically and chemically, when polish progressed to the diamond layer 7, polish stopped, and it has formed the metallic wiring 9 embedded at the layer insulation layer 6.
[0032]As a stopper layer of CMP, although silicon nitride and carbonization silicon are used now, the thing with such as high specific inductive capacity as [about] seven to ten poses a problem.

[0033]Since the diamond membrane of the porous structure by this invention comprises a diamond, its mechanical strength is high, it is chemically stable, and since it is lower-dielectric-constant-ized by moreover carrying out porous **, reduction of the capacity in multilevel interconnection is realizable by applying this invention to a stopper layer.
[0034][Working example 5] The porous diamond membrane of the about 1.5 micrometer thickness which carries out the spin coat of the diamond colloidal solution on a silicon oxide film, dries and heats by the method shown in the working example 3, and has a void of nano metric size in a film was formed.
[0035]The crosslinking process placed the sample into the glove box replaced by a nitrogen atmosphere by ordinary temperature and ordinary pressure, and performed it by holding in the HCDS steamy atmosphere diluted with chloroform for 1 hour. The membranous mechanical strength was measured in the amount of exfoliations of the film when the stuck tape is stripped (surface ratio to an attachment side). Before performing a crosslinking process, after HCDS concentration (weight %) performs a crosslinking process by 0.01% - 0.1 % to exfoliation and film destruction having been mostly seen all over the tape, it is about 10 to 30% of the amount of exfoliations.
Membranous adhesion and film strength were able to be raised.
Change of the specific inductive capacity seen with the refractive index at this time was hardly observed, as shown in drawing 8. When HCDS concentration was made high to 1 %, exfoliation was completely lost, but specific inductive capacity increased twice [about]. Since it is thought that the polymerization reaction of HCDS has produced this in a void, it can stop due to the fall of atmosphere moisture.
[0036]Dichloromethane may be used for dilution of HCDS in addition to chloroform.
[0037]
[Effect of the Invention]At this invention, it is **]. In a circuit board with highly integrated and miniaturization wiring of very large scale integration etc., this invention is the layer insulation of a circuit board about the diamond membrane of porous structure.
Therefore, the circumference of wiring is lower-dielectric-constant-ized by carrying out, while making it possible to reduce substantially the signal delay in the wiring which had become a problem conventionally, high-heat-resistance-izing of a circuit board and high intensity-ization can be attained, and it is ****** easily at high efficiency about the diamond membrane of still such a lower dielectric constant.

By adding the simple film strengthening process using bridge construction molecule material, a membranous mechanical strength can be made high.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a principle explanatory view of the diamond membrane of the porous structure by this invention.
[Drawing 2]It is an explanatory view of the structure of cross linkage of the chemical bond by the bridge construction molecule of this invention.
[Drawing 3]It is a flow chart showing one working example of the diamond membrane manufacturing process by this invention.
[Drawing 4]It is an explanatory view of the chemical bond by hexachloro disiloxane.
[Drawing 5]It is a sectional view of one working example of the bilayer circuit board which uses the diamond membrane by this invention.
[Drawing 6]It is an electron microscope photograph in which the porous image of the section of the diamond membrane by this invention is shown.
[Drawing 7]It is an explanatory view showing one working example of the process at the time of applying the porous structure diamond membrane of this invention to the stopper of a metallic wiring CMP process.
[Drawing 8]It is a graph which shows the relation of change of the refractive index and specific inductive capacity of diamond membrane when changing HCDS concentration in the crosslinking process using HCDS.
[Explanations of letters or numerals]
1: Base material
2: Barrier layer
3: The diamond layer of porous structure
4: Metallic wiring
5: The diamond enveloping layer of porous structure
6: The layer insulation layer which does not use diamond membrane
7: The diamond layer of porous structure
8: Metal layer
9: Metallic wiring
10: Diamond microparticles
11: Void
12: Chemical bond

[Translation done.]

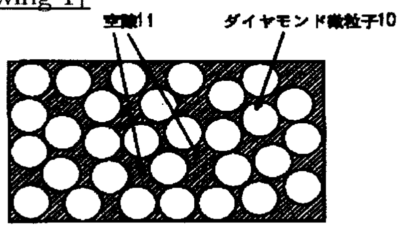
* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

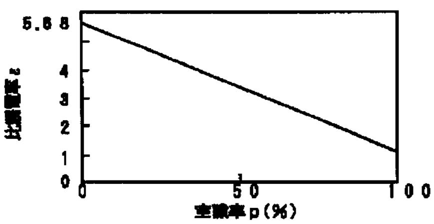
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]

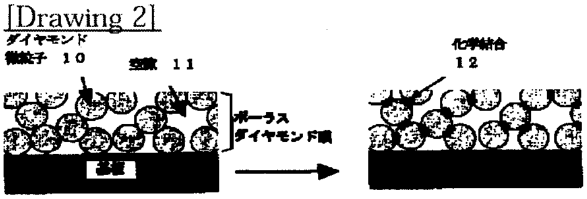


(a) ダイヤモンド膜のポーラス構造



(b) ポーラス構造ダイヤモンド膜の空隙率と比誘電率の関係

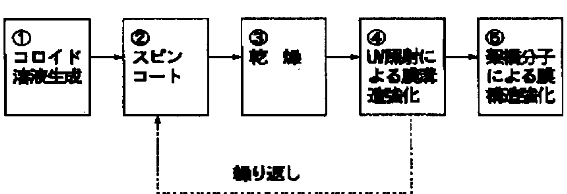
[Drawing 2]



(a) (b)

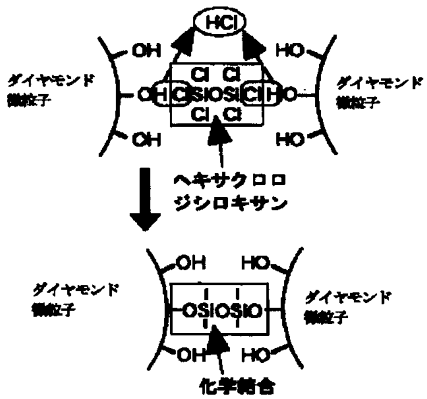
架橋分子による化学結合の架橋構造

[Drawing 3]



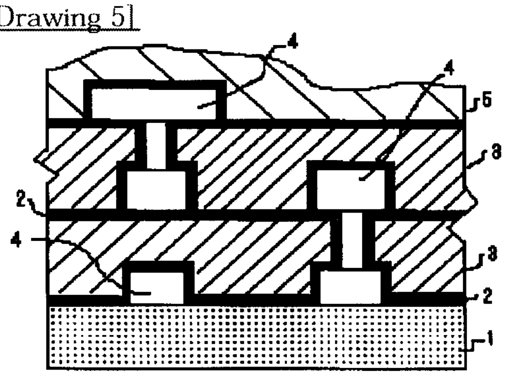
本発明によるダイヤモンド膜製造工程の1実施例

[Drawing 4]



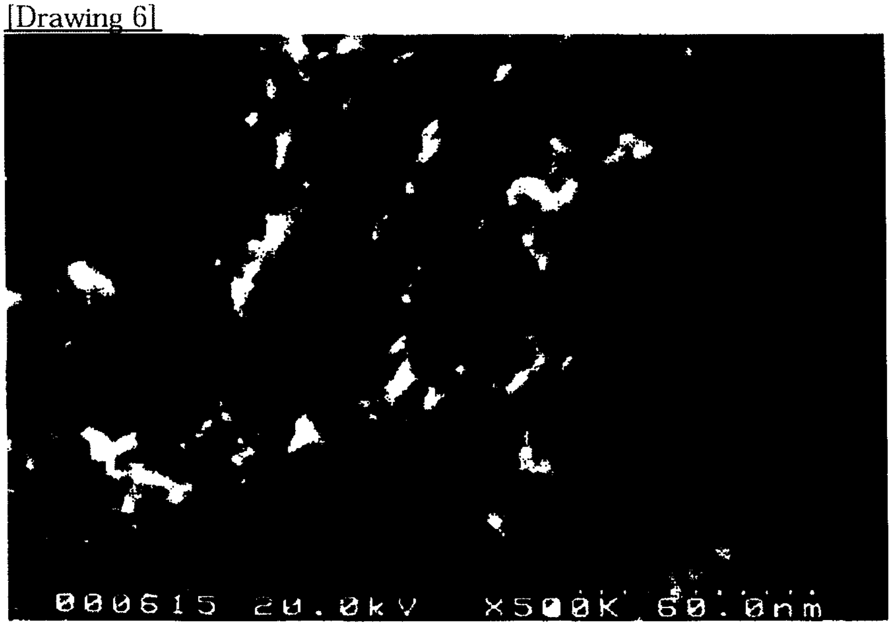
ヘキサクロロジシロキサンの化学結合

[Drawing 5]



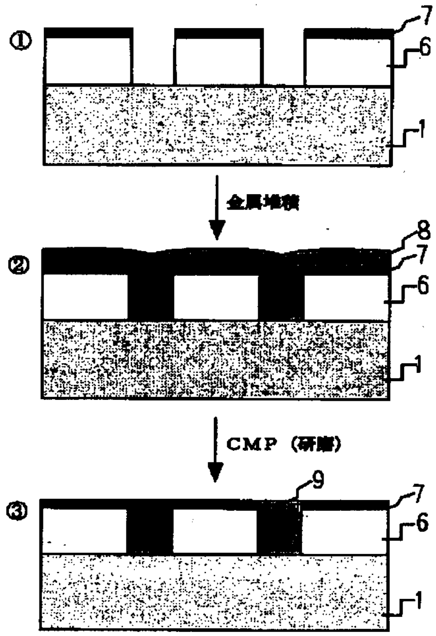
本発明によるダイヤモンド膜を使用した二層回路基板の１実施例

[Drawing 6]



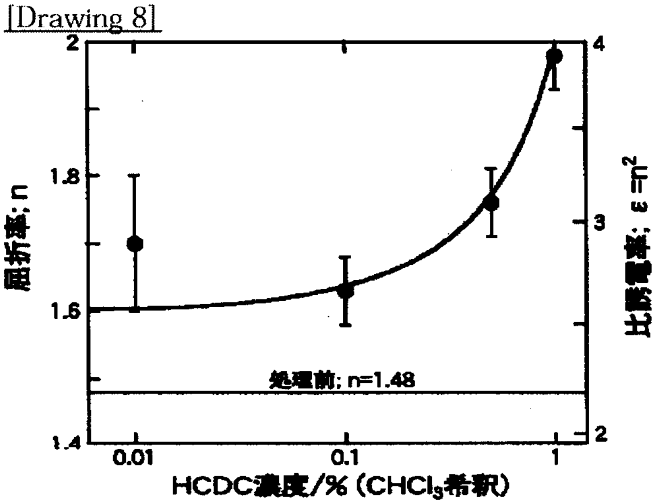
ダイヤモンド膜断面のポーラス像を示す電子顕微鏡写真

[Drawing 7]



本発明のダイヤモンド膜を金属配線CMP工程のストッパーに適用した1実施例

[Drawing 8]



HDCS濃度と屈折率および比誘電率の関係

[Translation done.]